



A Review and Outlook on Digital Asset Research

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Abstract. Digital assets have been a global issue that has received widespread attention from the academic community in recent years and have achieved many creative research results. This article provides a systematic review of the relevant research achievements at home and abroad, including the concept, formation mechanism, confirmation and reporting and management strategies of digital assets. It also explores future research directions. Its main purpose is to provide theoretical guidance and policy inspiration for in-depth research on digital assets in China, further improve the application of digital assets, standardize digital assets, and improve the efficiency of resource allocation of digital assets, in order to better condense the existing research consensus, display research perspectives, expand research thinking and promote the continuous deepening of related research.

Keywords: Digital Economy, Digital Assets, Digital Resources.

1 Introduction

Digital assets usually refer to non-monetary assets owned or controlled by enterprises or individuals, existing in the form of electronic data, held for sale in daily activities, or in the production process. Numerous facts and studies have shown that digital assets are widely present in countries around the world, especially in emerging market countries and developing countries. Digital assets are increasingly becoming a substitute mechanism for market and national assets, playing an increasingly important role in social and economic activities. Because of this, digital assets have been a global issue that has received widespread attention from the academic community in recent years, and have achieved many creative research results. This article reviews and sorts out relevant research results at home and abroad to reveal the meaning, formation mechanism, confirmation, and reporting of digital assets. Accordingly, it incorporates some theoretical reference significance and policy inspiration for us to further study the digital assets in China, improve the market trading system of social resources, regulate digital assets, and improve social resource allocation.

2 The Meaning of Digital Assets

The rapid transformation of modern information technologies such as big data, artificial intelligence, blockchain, and 5G has given rise to a large number of digital economic models, causing changes in national governance and having a profound impact on existing asset concepts, rules, and technological facilities. Digital assets are an important component of national assets. The new round of technological transformation brings new challenges and opportunities to digital asset management and services. What is digital asset? So far, there has been no consensus in the academic community regarding the answer to that question.

2.1 Digital Assets

Richard E. Peters (1974) believes that data assets can be regarded as assets equivalent to government bonds, corporate bonds and physical bonds. On his turn, Tony Fisher (2009) argues that, from the perspective of big data, "data is an asset." [1] Somehow in agreement with that, The World Economic Forum (2011) proposed that, personal data has become a new type of "asset class." Also, Victor Mayer Sch önberg and Kenneth Cook (2013) argue that, it is only a matter of time before data assets are included in the balance sheet. From their research findings, Zhu Yangyong and Ye Yazhen (2018) proposed a comparative analysis of related concepts such as information assets, digital assets, and data assets. According to the Institute of Cloud Computing and Big Data at the China Academy of Information and Communications Technology, data assets are "data resources that are owned or controlled by enterprises, which can bring future economic benefits to enterprises, and are recorded in physical or electronic mediums, such as files, electronic data, etc."

2.2 The Characteristics of Digital Assets

Although there are different views in the academic community on the definition of digital assets, the digital economy has the following characteristics in its connotation:

Digital sub-assets are a new type of assets. It is manifested as not causing losses, but also as having altruistic development. Traditional assets depend on the value of the assets themselves; and the number of sub-assets in existence depends on the user's own abilities.

Digital assets are an immutable asset. The above definition of digital assets is basically based on enumeration but, in reality, digital assets are complex and diverse. Therefore, they can be used by external value entities, and can also lay the foundation for the external ecological management of enterprises. According to the perspective of digital economics, the ownership and use rights of such digital assets are relatively independent, meaning that the owner of the digital assets sometimes does not have a clear identity as the user, but as an individual being aware of and seeking recourse after the assets have been illegally used.

Digital assets are an economic asset. Due to the government's control over a large amount of digital resources, according to the theory of digital resources, enterprises will

become dependent on digital resources and establish digital economic connections with the government to obtain more digital assets. So, in this sense, digital assets are an economic asset.

Digital assets are assets with derivative characteristics. Luo Min, Zhao Tianqi, and Guo Wangyue Rui (2020) believe that, as digital transactions and usage frequency continue to evolve, on the one hand, the self-replication of digital content brings asset proliferation and, on the other hand, changes in user base, which bring about an increase in the influence of digital assets.

Digital assets are virtual assets with strong attachment, small physical space occupation, convenient storage and portability, and no physical form. Cao Wenhao (2020) believes that the development of digital assets requires the use of emerging digital technologies such as blockchain and the Internet of Things; high investment costs from research and development to product development; strong replicability, with the number of replicates being dependent on market demand, uncertain quantity and difficult unit cost measurement; after successful research and development, maintenance and update costs need to be covered, which leads to the possibility of continuity and difficulty of cost measurement. Clarifying these characteristics of digital assets undoubtedly helps to deepen research and understanding of the connotation, formation mechanism, confirmation and reporting as well as management strategies and other issues of digital assets.

3 The Formation Mechanism of Digital Assets

How to analyze the formation mechanism of digital assets to understand the formation of digital assets? This is a key and challenging issue in digital asset research. From the existing literature, the research on the formation mechanism of digital assets mainly includes the following content:

3.1 The Formation of Digital Assets

At the beginning, it was Satoshi Nakamoto, who proposed digital assets. In "Bitcoin: A peer-to-Peer Electronic Cash System" (2008), he mentioned that, digital assets, which are now widely recognized as Bitcoin, were virtual currencies without specific physical forms. This viewpoint holds that Bitcoin can generate transactions and play the role of physical currency, allowing people to trade without cash and greatly facilitating their lives. This was the earliest source of digital assets.

Helen Meyer proposed "digital assets" in 1996 [2]. Albert Van Niekerk (2006) believed that digital assets were "any item of text or media that is formatted as binary source code and has usage rights." [3] The Intel Developer Forum (2013), however, considered that, the 30 new digital assets mainly included healthcare, education, and voting. In her turn, Elizabeth Yakel (2013) believed that libraries, archives and museums no longer considered digital images as objects, but rather treated them as digital assets. [4] After a further exploration of the area, the Unified Trustee Access to Digital Assets Law (2014) stipulated issues related to the access, management, and inheritance

of personal digital assets. Then, Wang Xiaoguang (2014) proposed a comprehensive understanding of the formation of digital assets based on professional knowledge in information management, combined with the connection and differences between digital assets and the related concepts. Li Jun and Kong Huawei (2014) found that digital assets are assets that can be owned and controlled by any entity, measured in value, and can generate transactions. According to Rod Genders and Adam Steena (2017), digital assets included any assets that were accessed and held online in digital form. [5] Russia (2018) presented the idea that, digital assets were "electronic form assets created using encrypted methods," including cryptocurrencies, tokens, etc., and made clear provisions on issues such as "mining" rules for digital assets and initial token issuance (ICO). Thailand (2018) suggested that the Digital Assets Act divided digital assets into cryptocurrencies and digital tokens.

With the continuous integration of the world economy, until the outbreak of the digital revolution today, as observed with the existence of personal Weibo, Moments, and Taobao's shopping records, each economic entity generates a large amount of digital resources every day, which constitutes the current source of digital assets.

3.2 Classification of Digital Assets

According to the different payment instruments operating in the digital world, digital assets are divided into four components: digital currency, virtual currency, cryptocurrency, and traditional financial assets. Digital currency, also known as "digital fiat currency," is presented in digital form and it is in use to support real-time transactions and unrestricted transfer of ownership; it has the function of legal tender for online payments. As regards virtual currency, it is not issued by central banks or public authorities, and may not be linked to a certain legal tender. However, it is a payment method accepted by legal or natural persons and can be electronically transferred, stored, or traded. As for cryptocurrencies, they have emerged based on blockchain technology's encryption algorithms and decentralized tools. In reference to traditional digital financial assets, they refer to the digitized traditional financial assets.

In addition, scholars, such as He Yukun (2020), have studied the classification of digital assets from two aspects: firstly, based on the different content of digital assets, they can be divided into entertainment and leisure digital assets, online learning digital assets and conceptual products; secondly, according to the different forms of digital assets, digital assets are divided into standardized digital assets and non-standard digital assets. Standardized digital assets have clear prices and manifestations, while non-standard digital assets do not have a clear algorithm to mark the unique values of each part.

4 Recognition of Digital Assets

What is the recognition of digital assets like, or why do digital assets need to be recognized? This is a legitimate question because digital assets, not only support and influence the development of social and economic forms, but also promote the emergence

of new business models and economic forms. Whether they are relatively mature traditional assets or digital assets that have initially been formed, their presence generate both a challenge and an opportunity for a country's economic development. Thus, Wang Lei (2019) proposed that, in terms of ownership confirmation, data property rights should not be established within the protection boundaries of the existing legal framework. Yao Jia (2019) urged the analysis of data ownership from the perspective of combining economics and law, advocating for shelving discussions and splitting, combining and allocating different rights of data assets to create feasible rules and paths for data asset allocation. Qin Rongsheng (2020) proposed that the recognition of digital assets should meet two conditions: firstly, the economic resources that have the right to generate economic benefits belong to the enterprise; secondly, enterprises can measure the cost and value of economic resources. Accordingly, whether or not digital assets belong to individuals or enterprises is a matter of ownership.

4.1 Sales Confirmation of Digital Products

Jin Yanmei (2018) found that, when studying the sales recognition of digital products, if the completion time of transactions and the acquisition time of returns for conceptual and symbolic digital assets are inconsistent, it is necessary to separately treat the sales revenue of symbolic and conceptual digital products. For symbol and conceptual digital products and confirmation are completed in three steps: first, by obtaining the corresponding price after the transaction and processing it as a prepayment; secondly, after successful consumption, it should be processed according to its actual goods or services; thirdly, refunds are not allowed and are not included in revenue after the expiration of the refund period. For digital products other than symbols and conceptual categories, as their sales and revenue acquisition are completed at the same time, they should be recognized at the transaction price.

4.2 Recognition of Sales Costs of Digital Assets

Jin Yanmei (2018) found that the sales revenue and cost of traditional goods correspond to each other, while the production and manufacturing costs of digital products are very low except for research and development investment. If the traditional accounting cost recognition method is used to recognize its cost as 0, it is obviously inappropriate. Therefore, based on the sales decision of patents for digital products, two cost recognition methods are selected. Firstly, when the right to use digital assets and the patent right are sold simultaneously, the production cost of the digital asset is converted into the cost of sales when income is obtained; secondly, when digital products only sell usage rights and retain patent rights, the amortization expenses are converted into sales costs according to the predetermined amortization method.

In addition, the recognition of digital assets can also bring other benefits to enterprises. If a company encounters financial difficulties, those with digital assets are more likely to receive assistance; enterprises with digital assets are more likely to enter the digital economy market than those without digital assets; companies with digital assets can earn higher returns from going public than those without digital assets, meaning

that companies with digital assets have a relatively higher issuance price and lower listing costs.

5 Measurement of Digital Assets

At present, the academic research on the measurement of digital assets at home and abroad mainly focuses on the initial measurement and subsequent measurement of digital assets. However, so far, there has been no consistent conclusion in this area of research. Zhai Lili and Wang Jiani (2016) believed that, in the measurement of digital assets, an improved LSM model was used to construct a data asset evaluation model from the perspective of physical options and leakage characteristics. Huang Le et al. (2018) suggested using three asset valuation methods to improve the data asset return model and conducting case empirical testing. Qin Rongsheng (2020) believed that there was an issue between initial measurement and subsequent measurement of data assets.

5.1 Initial Measurement

Scholars have shown that digital assets face measurement risks, which are beneficial for the initial measurement of enterprises and enhance their value. This is mainly because when digital product development fails, R&D investment can only be recorded as expenses and cannot be capitalized for recognition. Only when a company's digital product development is successful and generating profits can the R&D investment be capitalized and recognized. In other words, the initial measurement object of digital assets is their cost, mainly including the cost of purchasing digital assets and the cost of independently researching and developing digital assets. These two types of digital assets have different acquisition methods, and their recorded values can be measured separately. Firstly, externally purchased digital assets are consistent with traditional commodity processing methods, and the corresponding accounts being paid, the relevant taxes and sales expenses are included in the cost. Secondly, the treatment of independently developed digital assets is consistent with that of intangible assets, and the cost time range should be from the moment when the research and development is about to succeed to the moment when the digital product meets the asset recognition conditions. All related expenses during this period should be recognized as costs.

5.2 Subsequent Measurement

Jin Yanmei's (2018) empirical study found that the subsequent measurement of digital assets could sometimes have a negative impact on enterprises and damage their value. This is because there are two methods for subsequent measurement. Firstly, the amortization method. Enterprises should accurately estimate the time of economic benefits when selling digital products, and be cautious in amortization. Based on experience, buyer preferences and industry development trends, the shorter the amortization period, the better. Due to the high functionality and limitations of digital products as well as their short update cycles, new digital products will continue to emerge in the market,

posing significant operational and sales risks and decreasing value. In response to this situation, the amortization method should be accelerated to allocate more costs when the revenue of digital products is high, and less costs when the revenue is weak, so as to rationalize the allocation of cost amortization. Secondly, confirm the conditions and handling of termination. In the era of Internet plus, the competition of digital products is very fierce. To maintain revenue and market share, digital products must be constantly upgraded. When the upgrade process lags behind, new digital products replace the original digital products. If it cannot create economic benefits for the enterprise, it should be derecognized and the book value should be written off.

In addition, the recognition of digital assets exhibits their aspects in addition to the aforementioned performance. Scholar Wu Minghui's (2003) empirical research found that for the enterprises with digital assets, digital assets cannot be classified as material assets or intangible assets, and a separate category of "digital assets" should be established; scholar Shan Shihui's (2020) study found that the accounting recognition of enterprises with digital assets is significantly lower than that of enterprises without digital assets.

6 Report on Digital Assets

In terms of information reporting on data assets, existing researchers have drawn on the accounting treatment and accounting methods of intangible assets. Zhang Qiwan (2006), for example, believed that the report on digital assets could also add a "digital asset" item to the asset item in the balance sheet to reveal the monetary value of digital assets; secondly, disclosure of information about digital assets in a non-monetary form included the expected annual cash flows and their discount rates, market share, market reputation, brand, and customer dependence of digital assets; the risks faced by digital assets should be appropriately disclosed regarding the risk factors of digital assets. Liu Yu (2014) believed that after the huge difference between Facebook's book asset value and market valuation, data assets should be included in the accounting system, and it is recommended to set data assets under the "intangible assets" account for accounting and disclosure. Zhang Junrui et al. (2020) suggested designing accounting treatment methods and information presentation models that are different from existing intangible asset accounting systems based on the classification of data asset uses.

In addition, Qin Rongsheng (2020) highlighted the fact that, if the book value is inconsistent with the tax basis, deferred income tax assets or deferred income tax liabilities need to be recognized to reflect the appreciation of digital assets. The report of digital assets will not be worn out due to use in financial statements. Consequently, depreciation or amortization is not required in daily accounting. A "digital asset" item can be set up in the balance sheet to classify production and consumption digital assets, and reclassify self-use and sellable digital assets.

7 Management Strategies for Digital Assets

It can be seen that the academic community at home and abroad has achieved many creative research results in the field of digital assets, revealing the meaning, formation mechanism, confirmation, and reporting of digital assets, laying a theoretical foundation for us to study the management strategies of digital assets and opening up the core of digital asset research. However, there are still some issues that need to be further considered, and the management strategies for digital assets need to be studied from the following aspects.

7.1 Improve Personal Cognitive Abilities

Utilize digital economy thinking, iterate the business operation model of digital products, businesses and services guided by the digital economy, and strengthen the utilization and protection of personal digital assets; with shared thinking, the government can release digital information that may bring to users in the future into stronger cooperation through official platforms, open special forums to mobilize user participation, and demonstrate the legal protection of personal digital assets; that way embracing the rationality of digital assets is a possibility.

7.2 Strengthen Industry Self-discipline Management

Establish a trust system, incorporate the circulation of personal digital assets into the industry, accurately define the ownership of personal digital assets, formulate standardized operating norms for digital controllers and owners, and promote the evaluation and certification of the compliance of personal digital asset circulation; standardize the trading of personal digital assets, establish standards for the review, implementation, confirmation, settlement and other processes of personal digital assets, coordinate market trading order, and safeguard the legitimate rights and interests of both parties involved in the transaction; on the basis of fully considering the characteristics of personal digital assets and market research, unify the pricing model or program of personal digital assets, improve the prediction of the effectiveness of personal digital asset use and transaction prices, and coordinate the imbalance between buyer demand and seller supply.

7.3 Strengthen Intelligent Security Protection

Through information security technologies such as identity authentication, access control and application security protocols, programs are pre-set according to user needs to collect and process numerous real-time personal data information stored on public servers and clear personal privacy data. These involve anticipating potential network risks on the basis of leveraging firewall technology protection functions, increasing the setting of intelligent systems and interactive interfaces, improving the ability to predict, alarm, and protect against initial attacks, and buying time and channels for the transfer, backup, and destruction of personal digital assets; strengthening the online asset control

and developing a network asset management system for personal digital assets based on blockchain technology.

7.4 Improve the Legal and Regulatory System

Establish a physical legal system, formulate macro-guidance laws and specific or specialized laws based on the overall operation status of personal digital assets, and take legal punishment for illegal possession or intentional destruction of personal legal digital property ownership through violent or non-violent, public or secret methods, such as seizing, misappropriating, transferring, tampering with, and destroying, to safeguard personal legal rights; establish a sound procedural legal system, improve the application system of network monitoring and investigation methods, and strengthen the application of blockchain technology in reconnaissance activities; improve relevant supporting laws, attach importance to the legal protection of personal digital assets, and at the same time, pay attention to regulating the market activities of personal digital assets. Through specific and operable laws and regulations, implement comprehensive and full process supervision of the initial acquisition, market transactions, and asset storage of personal digital assets.

8 Conclusion and Outlook

Existing literature closely follows the forefront of digital assets and has conducted corresponding research on many key issues, proposing certain viewpoints and suggestions. However, it should be pointed out that there are still issues that need further improvement in the existing research. On the one hand, many studies still remain at the level of phenomena and viewpoints, which need to be strengthened in terms of theoretical creativity, policy reference and practical guidance. On the other hand, some studies on the essence and application value of the digital economy are not fully understood, therefore an elaborate explanation is needed. Firstly, there is no unified definition of the concept of digital assets. Secondly, the theoretical community can collaborate with practical departments to conduct systematic research on digital assets, form actionable research recommendations, and promote the process of incorporating numbers into the accounting system. Thirdly, while further establishing and improving user privacy protection policies, ownership should be diluted. Starting from the perspective of exploration rights, usage rights, and revenue rights of digital assets, relevant legal and accounting issues related to the recognition of data asset ownership should be further studied to provide a basis for incorporating digital assets into the accounting system. Fourthly, establishing a functional system and institutional framework for the Chief Information Officer and Chief Financial Officer regarding the utilization, accounting, and other aspects of digital assets is crucially important, in order to build institutional guarantees for incorporating digital assets into the accounting system. This article focuses on the research and analysis of digital assets, clarification of the concept, formation mechanism, confirmation and measurement, reporting, and management strategies of data assets. However, there is no in-depth discussion on the ownership confirmation, value

measurement, information reporting and corresponding financial system construction of digital assets, which will be the direction of future research. In addition, there are still some issues that need to be further considered in studies, mainly manifested in the following aspects.

8.1 Regarding the Ownership and Accounting Recognition of Digital Assets

From the above analysis, it can be seen that there is currently no consensus in empirical research on the relationship between digital assets and corporate performance. The important reason for this result is that the impact of digital assets on business performance is constrained by the corporate environment. In other words, the impact of digital assets on business performance may vary in different corporate environments. For example, the impact of corporate executives with digital assets on business performance is constrained by internal mechanisms, as well as external institutional environments such as government regulation, legal systems and public opinion. Therefore, when studying the relationship between digital assets and business performance, it is necessary to consider the constraining effect of the corporate environment. Only in this way can we draw more objective conclusions.

8.2 Regarding the Measurement Level of Digital Assets

From the above analysis, it can be seen that current research on the measurement of digital assets mainly focuses on the micro level, with little involvement in the macro-economic level. In terms of allocation of social resources, especially those monopolized by the government, digital assets, as a substitute mechanism for the market and system, will inevitably affect the allocation of social resources and the development of the social economy. Therefore, strengthening the research in this area can help us to comprehensively and deeply reveal the economic consequences of digital assets and provide some theoretical guidance and empirical evidence for the government to further improve the allocation mechanism of social resources. By combining the measurement models and asset evaluation methods, and through practical research on the digital utilization and pricing strategies of typical Internet platform enterprises, a measurement system with both theoretical basis and market fair value can be established.

8.3 The Issue of Information Reporting on Digital Assets

There are few existing literature that address this issue. Enterprises establish connections with the government in order to obtain more digital resources, which is a manifestation of imperfect markets and systems. It will cause unfair distribution of social resources and competition among enterprises, reduce the allocation of social resources, and generate huge social costs. Therefore, it is necessary to strengthen the governance of digital assets and regulate the digital economy market. This is not only a practical choice question, but also a theoretical question that needs to be studied and given a clear answer.

Digital assets are another form of asset that is independent of intangible assets and should belong to the first level accounting subject. A systematic analysis can be conducted based on the relevant conditions and processes for incorporating digital assets into the accounting system, as well as the requirements for information disclosure.

8.4 The Issue of Management Strategies for Digital Assets

From the above-given analysis, it can be seen that from the perspective of financial governance, internal management systems and external regulatory systems related to digital assets can also be studied, in order to ensure the scientific methods and standardized procedures for incorporating digital assets into the accounting system.

In addition, there are many methods proposed in existing literature regarding the recognition and measurement of digital assets, all of which have certain limitations and have made it difficult to accurately measure the standard system of digital assets. Therefore, it is necessary to conduct further research on this issue.

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